constructing an enhanced configuration; and

evaluating the enhanced configuration.

71. (NEW) The method of Claim 70 wherein the nozzle is of a jet engine.

72. (NEW) The method of Claim 70 wherein the nozzle is a high aspect ratio nozzle.

73. (NEW) The method of Claim 70 wherein the step of evaluating the enhanced configuration comprises performing at least one thrust stand test.

74. (NEW) The method of Claim 70 wherein the behavior of the experimental configurations is selected from a group consisting of thrust vectoring angle, thrust efficiency, and discharge coefficient.

REMARKS

The Examiner alleges that the declaration is defective. As such, a new declaration is submitted in compliance with 37 CFR 1.67(a).

The Drawings are objected to because they do not photocopy well, the vectors allegedly are not shown properly, they allegedly fail to comply with 37 CFR 1.84(p)(5), leadlines on Figure 1C are allegedly not drawn to correct locations, and labeling for x-y-z Cartesian coordinates are unclear. Further, the drawings are objected to under 37 CFR 1.83(a) because drawings must show every feature of the invention specified in the claims. Revised drawings are submitted. No new matter has been added.

The Specification is objected to for allegedly failing to provide an adequate written description. The Examiner cites inconsistencies with the drawings. The drawings have been revised and replacement paragraphs are provided. No new matter has been added.

The Claims 1-30 are rejected under 35 U.S.C. §112, 1st Paragraph, due to the alleged failure of the written description requirement. Claim 15 is rejected under 35 U.S.C. §112, 1st Paragraph for alleged enablement problems. Claims 1-25 are rejected under 35 U.S.C. §112, 2nd Paragraph as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claim 12 has an antecedent problem. The claims 1-8 and 10-30 are further rejected under 35 U.S.C. §103. New Claims are submitted.

OBJECTIONS TO THE DRAWINGS

New drawings are submitted without color. No new matter has been introduced. As to the objections regarding Figures 5A-5C, the vectors indicate a direction of injection. As such, the vectors are shown properly.

The drawings have been amended to include the references 32, 277 and 285 as requested. Further, the leadlines associated with Figure 1C have been adjusted. The x-y-z coordinate system has been amended for Figures 2 and 3.

As to the 37 CFR 1.83(a) objections, in the various figures, injection of fluid is shown. This fluid and its effects are subsequently defined in the description. As such, Applicants respectfully submit that the drawings meet with the requirements of 37 CFR 1.83(a).

OBJECTIONS TO THE SPECIFICATION

The specification has been amended with the replacement paragraphs above. In addition, Applicants respectfully submit that "aft" has a clear definition as seen, for example, in Webster's Seventh New collegiate Dictionary (aft: near, toward, or in the stern of a ship or the tail of an aircraft; rearward; or after).

REJECTION OF THE CLAIMS

REJECTION UNDER 35 U.S.C. 112, 1st PARAGRAPH

The Applicants respectfully request that the Examiner cancel Claims 1-30 without prejudice. With the revised drawings and replacement paragraphs, the Applicants submit that the application meets 35 U.S.C. §112, 1st Paragraph. As such, Applicants respectfully traverse the 35 U.S.C. §112, 1st Paragraph rejection.

REJECTION UNDER 35 U.S.C. 103

One aspect of the invention may be found in injecting fluid in a plane parallel to the intended vectoring plane of a 3D nozzle. However, the fluid may be injected in a plane parallel to the intended vectoring plane in a 1D or 2D nozzle.

Much of the prior art injects fluid in an axis-symmetric direction as seen in McCullough (3,698,642), Kranz (4,351,479), Warren (3,204,405), Rich (2,952,123), Conrad (3,132,476), Ernst (3,285,262), Howell (3,737,103), and Williams (3,759,039), among others. As such, they do not apply to 3D nozzles. Therefore, Applicants respectfully submit that the invention is not obvious.

CONCLUSION

Revised drawings are submitted. Replacement paragraphs are submitted. Claims 1-30 have been canceled without prejudice. New Claims 31-74 are submitted. As such, the Applicant respectfully submit that all requirements have been meet. Therefore Applicant request that a notice of allowance be issued.

If the Examiner has any questions or comments, or if further clarification is required, it is requested that the Examiner contact the undersigned at the telephone number listed below.

The Commissioner is hereby authorized to charge any additional fees or credit any overpayments to Deposit Account No. 50-1343 of Hughes & Luce, LLP.

Respectfully submitted,

HUGHES & LUCE, L.L.P.
Agent for Applicants

John R. Schell
Reg. No. 50,776

March 28, 2002
1717 Main Street, Suite 2800
Dallas, Texas 75201
Tel. (214) 939-5500
Fax. (214) 939-6100

Exhibit "A"

Substitute Paragraphs

Replace the paragraph beginning on page 19 line 23 with the paragraph as follows:

FIGURE 1A is an isometric depiction of a high aspect ratio biconvex aperture nozzle with injection ports for multi-axis thrust vectoring. FIGURE 1B presents a plan view of high aspect ratio aperture nozzle 10 illustrating injector ports 12**,** **[and]** 14**, 16 and 18**. Throat slots 12 **and 16** serve as injector ports proximate to the throat of the nozzle and flap slots 14 **and 18** serve as injector ports proximate to the nozzle flap. FIGURE 1C illustrates two additional sets of injectors yaw slots 16 **and 18** and pitch slots **[18]** **12 and 14**. These dedicated sets of injectors 12, 14, 16 and 18 can be arrayed around the periphery of nozzle 10 to achieve vectoring in pitch and/or yaw vector planes as is shown in FIGURE 1A by thrust vector 19. The injector slots or pitch slots **[18]** **12 and 14** shown in FIGURE 1C are located on the top and bottom surfaces of nozzle 10 and are intended to provide pitch plane vectoring. While those injectors such as yaw slots 16 **and 18** located on the sidewalls are intended for yaw plane vectoring. Slots 12, 14, 16 and 18 can be swept at an angle similar to that of the exit plane trailing edge. Such injectors direct injected flow having vector components, I_x, I_y, and I_z, opposed to that of the primary flow vector V_{pf} in the intended vectoring plane, yz for pitch or xz for yaw of FIGURE 1D with the special cases of a zero sum x component for pitch or zero sum y component for yaw.

Replace the paragraph beginning on page 38 line 10 with the paragraph as follows:

FIGURE 10 depicts one embodiment of injectors 276 and 277 according to the present invention, and the effect that injectors 276 and 277 can have on flow 214 exiting an exhaust chamber 262 through nozzle opening 272. When injectors 276 and 277 are turned off so that they do not inject a secondary flow, the effective cross sectional area of nozzle opening 272 is defined by the area of the plane generally perpendicular to flow 214 between the walls 280 of nozzle 268. When symmetric and opposed injectors 276 and 277 are provided similar secondary flows 284 and 285 into flow 214, the secondary flows evenly block the nozzle's opening to vary the nozzle's discharge coefficient, which is analogous to effective cross sectional flow area, to decrease the effective cross sectional area of nozzle opening 272 to the area depicted by numeral 282. Thus, nozzle opening 272 depicts an effective cross sectional area that could correlate to an engine in afterburner, and nozzle opening 282 depicts an effective cross sectional area that could correlate to an engine when not afterburning.

Replace the paragraph beginning on page 40 line 1 with the paragraph as follows:

Next, the orientation and location of injectors 276 and 277 can be arranged to maximize penetration into primary flow 214. Injectors 276 and 277 provide secondary flows 284 **and 285** that **[is]** **are** at an injection angle 286 from being completely opposed to the direction of primary flow 214 along the longitudinal axis of nozzle 268. FIGURE 10 depicts angle of 286 as 15 degrees from the longitudinal axis of nozzle 268, although angles of between zero and 30 degrees will provide enhanced blockage of nozzle opening 272. In one alternative embodiment, the angle 286 of injectors 276 and 277 can be adjusted to a range of values. Injector 276 is located at the beginning of throat 270 so that the secondary flow from injector 276 is aimed into the subsonic portion of the nozzle flow field 212. Injection of the secondary flow into the subsonic portion of the flow field prevents the formation of shocks, which can significantly impact the nozzle's thrust efficiency.

Replace the paragraph beginning on page 40 line 20 with the paragraph as follows:

Finally, injectors 276 and 277 can be incorporated into various nozzle designs so that the nozzle design, injector mass flow characteristics, injector orientation, injector location and the secondary flow pulse characteristics cooperate to provide maximum blockage for a given secondary flow. Referring to FIGURE 11, one effective internal nozzle convergence contour is depicted. Exhaust chamber 262 is adapted to accept engine exhaust at an afterburner duct 290, and to provide the exhaust to throat 270. Exhaust chamber 262 has a high discharge, smooth transition contour shape. Although exhaust chamber 262 can have a variety of profiled choked nozzle convergence shapes to enhance the effect of injectors 276, an ellipse shape is depicted in FIGURE 11. The ellipse shape has a major axis 292 with vertices along its major axis having a length depicted as a, and a minor axis 94 with a vertices along its minor axis having a length depicted as b. The afterburner duct 290 into exhaust chamber 262 has a diameter proportional to major axis 292, such as four times the distance a. Length b of minor axis 294 establishes the contraction ratio of nozzle 268, meaning the ratio of the areas of afterburner duct 290 and throat 270, and can be set at a value similar to that of the F110-GE-129 turbofan engine's nozzle, such as approximately 1.8.

Replace the paragraph beginning on page 42 line 6 with the paragraph as follows:

Throat 270 can have a number of aperture shapes, including an axisymmetric, rectangular (2-D), elliptical, diamond, triangular shapes, and other low observable RADAR and IR configurations. FIGURE 11 depicts a rectangular throat aperture which supports two opposing injectors 276 **and 277** formed as slots that encompasses the full periphery of the top and bottom of the rectangular-shaped throat 270. Each injector 276 **and 277** can provide a uniform flow along the entire slot from a single duct, or can include a number of smaller injection components within each slot which can cooperate to provide a uniform flow or a flow that varies along the slot. Injectors 276 **and 277** **[is]** **are** placed within throat 270 proximate to exhaust chamber 262, such as one nozzle throat radius from the nozzle's centroid 300.

Replace the paragraph beginning on page 43 line 16 with the paragraph as follows:

Referring now to FIGURE 12, lines 304 represent the mass flow characteristics of flow 214, passing through nozzle 268. As flow 214 passes through throat 270, the energy of flow 214 is translated from a high pressure and low velocity into a low pressure and high velocity. Injectors 276 and 308 provides a flow that partially blocks throat 270 and thus skews sonic plane 302 of flow 214. When a plurality of injectors provide a symmetrical secondary flow around the periphery of throat 270, the effective cross sectional area of throat 270 is decreased, causing an increase in pressure within exhaust chamber 262 and an increase in the velocity of flow 214 as it accelerates through throat 270. The pressure within afterburner duct **[88]** can be controlled by controlling the amount of blockage provided by the secondary flow from injectors 276.

Claims as of March 28, 2002 Under Rule 1.121

31. A nozzle for vectoring a primary flow of a fluid flowing through an enclosed volume, the nozzle being a 3D nozzle and having an inside surface, the nozzle comprising:

a plurality of injectors with port openings arranged along the inside surface of the 3D nozzle, each of the plurality of injectors adapted to expel an injection fluid in a direction within the enclosed volume, the direction inclined to oppose the primary flow of the fluid and approximately parallel to an intended vectoring plane.

32. The nozzle of Claim 31, the nozzle further comprising:

a throat, the throat comprising a region within the nozzle of lowest cross-sectional area, the throat being situated in a path of the primary flow of the fluid.

33. The nozzle of Claim 32 wherein the plurality of injectors is located proximate to the throat.

34. The nozzle of Claim 33, the nozzle further comprising:

a second plurality of injectors located downstream of the throat and arranged along the inside surface of the 3D nozzle, each of the second plurality of injectors adapted to expel the injection fluid in a second direction within the enclosed volume, the second direction inclined to oppose the primary flow of the fluid and approximately parallel to the intended vectoring plane.

35. The nozzle of Claim 34 wherein the plurality of injectors and the second plurality of injectors expel the injection fluid asymmetrically, resulting in a change in a thrust vector associated with the primary flow of the fluid, the change in the thrust vector lying within the intended vectoring plane.

36. The nozzle of Claim 35 wherein the plurality of injectors and the second plurality of injectors expel the injection fluid in pulses.

37. The nozzle of Claim 33, the nozzle further comprising:

a second plurality of injectors located proximate to the throat, the second plurality of injectors having port openings arranged along the inside surface opposite of the plurality of injectors, each of the second plurality of injectors adapted to expel the injection fluid in a second direction within the enclosed volume, the second direction inclined to oppose the primary flow of the fluid and approximately parallel to the intended vectoring plane.

38. The nozzle of Claim 37 wherein the plurality of injectors and the second plurality of injectors expel the injection fluid symmetrically, resulting in a change in a discharge coefficient in the nozzle.

39. The nozzle of Claim 38 wherein the plurality of injectors and the second plurality of injectors expel the injection fluid in pulses.

40. The nozzle of Claim 31 wherein the injection fluid is a compressed gas.

41. The nozzle of Claim 31 wherein the injection fluid is fuel.

42. The nozzle of Claim 31, the nozzle further comprising:
at least one controller, the at least one controller operable to direct at least one of the plurality of injectors to expel the injection fluid.

43. The nozzle of Claim 31, the nozzle further comprising:
at least one controller, the at least one controller operable to direct at least one of the plurality of injectors to expel of the injection fluid in pulses.

44. A method for vectoring a primary flow of fluid in a 3D nozzle, the 3D nozzle having a throat, the throat comprising a region within the 3D nozzle of lowest cross-sectional area, the throat being situated in a path of the primary flow of fluid, the method comprising:
expelling from a plurality of injectors an injection fluid in a direction inclined to oppose the primary flow of the fluid and approximately parallel to an intended vectoring plane, the plurality of injectors located proximate to the throat.

45. The method of Claim 44, the method further comprising:
expelling from a second plurality of injectors an injection fluid in a direction inclined to oppose the primary flow of the fluid and approximately parallel to an intended vectoring plane, the second plurality of injectors located downstream of the throat.

46. The method of Claim 44, the method further comprising:
expelling from a second plurality of injectors the injection fluid in a direction inclined to oppose the primary flow of the fluid and approximately parallel to an intended vectoring plane, the second plurality of injectors located approximate to the throat.

47. The method of Claim 44 wherein the step of expelling comprises expelling in pulses.

48. The method of Claim 44 wherein the injection fluid is a compressed gas.

49. The method of Claim 44 wherein the injection fluid is a fuel.

50. The method of Claim 44 wherein the injection fluid

51. A nozzle for vectoring a primary flow of fluid, the primary flow of fluid flowing through an enclosed volume, the nozzle having an inside surface and a throat, the throat comprising a region within the nozzle of lowest cross-sectional area, the throat being situated in a path of the primary flow of fluid, the nozzle comprising:

a plurality of injectors with port openings arranged along the inside surface of the nozzle, the plurality of injectors arranged such that the plurality of injectors are not aligned parallel to the path of the primary flow of fluid, each of the plurality of injectors adapted to expel an injection fluid in a direction within the enclosed volume, the direction inclined to oppose the primary flow of fluid and approximately parallel to an intended vectoring plane.

52. The nozzle of Claim 51 wherein the plurality of injectors is located proximate to the throat.

53. The nozzle of Claim 52, the nozzle further comprising:

a second plurality of injectors located downstream of the throat and arranged along the inside surface of the nozzle, the second plurality of injectors arranged such that the second plurality of injectors are not aligned parallel to the path of the primary flow of fluid, each of the second plurality of injectors adapted to expel the injection fluid in a second direction within the enclosed volume, the second direction inclined to oppose the primary flow of the fluid and approximately parallel to the intended vectoring plane.

54. The nozzle of Claim 53 wherein the plurality of injectors and the second plurality of injectors expel the injection fluid asymmetrically, resulting in a change in a thrust vector associated with the primary flow of the fluid, the change in the thrust vector lying within the intended vectoring plane.

55. The nozzle of Claim 54 wherein the plurality of injectors and the second plurality of injectors expel the injection fluid in pulses.

56. The nozzle of Claim 52, the nozzle further comprising:

a second plurality of injectors located proximate to the throat, the second plurality of injectors having port openings arranged along the inside surface opposite of the plurality of injectors, the second plurality of injectors arranged such that the second plurality of injectors are not aligned parallel to the path of the primary flow of fluid, each of the second plurality of injectors adapted to expel the injection fluid in a second direction within the enclosed volume, the second direction inclined to oppose the primary flow of the fluid and approximately parallel to the intended vectoring plane.

57. The nozzle of Claim 56 wherein the plurality of injectors and the second plurality of injectors expel the injection fluid symmetrically, resulting in a change in a discharge coefficient in the nozzle.

58. The nozzle of Claim 57 wherein the plurality of injectors and the second plurality of injectors expel the injection fluid in pulses.

59. The nozzle of Claim 51 wherein the injection fluid is a compressed gas.

60. The nozzle of Claim 51 wherein the injection fluid is fuel.

61. The nozzle of Claim 51, the nozzle further comprising:
at least one controller, the at least one controller operable to direct at least one of the plurality of injectors to expel the injection fluid.

62. The nozzle of Claim 51, the nozzle further comprising:
at least one controller, the at least one controller operable to direct at least one of the plurality of injectors to expel of the injection fluid in pulses.

63. A method for vectoring a primary flow of fluid in a nozzle, the nozzle having a throat, the throat comprising a region within the nozzle of lowest cross-sectional area, the throat being situated in a path of the primary flow of fluid, the method comprising:
expelling from a plurality of injectors an injection fluid in a direction inclined to oppose the primary flow of the fluid and approximately parallel to an intended vectoring plane, the plurality of injectors located proximate to the throat and arranged such that the plurality of injectors are not aligned parallel to the path of the primary flow of fluid.

64. The method of Claim 63, the method further comprising:
expelling from a second plurality of injectors an injection fluid in a direction inclined to oppose the primary flow of the fluid and approximately parallel to an intended vectoring plane, the second plurality of injectors located downstream of the throat and arranged such that the second plurality of injectors are not aligned parallel to the path of the primary flow of fluid.

65. The method of Claim 63, the method further comprising:
expelling from a second plurality of injectors an injection fluid in a direction inclined to oppose the primary flow of the fluid and approximately parallel to an intended vectoring plane, the second plurality of injectors located approximate to the throat and arranged such that the second plurality of injectors are not aligned parallel to the path of the primary flow of fluid.

66. The method of Claim 63 wherein the step of expelling comprises expelling in pulses.

67. The method of Claim 63 wherein the injection fluid is a compressed gas.

68. The method of Claim 63 wherein the injection fluid is a fuel.

69. The method of Claim 63 wherein the injection fluid

70. A method for designing a nozzle, the method comprising:
analyzing a baseline configuration of the nozzle;
establishing a design study matrix of experimental configurations, the design study matrix comprising the experimental configurations, each of the experimental configurations being different by at least one value of one or more matrix variables;
conducting computational fluid dynamic analysis on the experimental configurations;
identifying effects of the matrix variables on behavior of the experimental configurations;
constructing an enhanced configuration; and
evaluating the enhanced configuration.

71. The method of Claim 70 wherein the nozzle is of a jet engine.

72. The method of Claim 70 wherein the nozzle is a high aspect ratio nozzle.

73. The method of Claim 70 wherein the step of evaluating the enhanced configuration comprises performing at least one thrust stand test.

74. The method of Claim 70 wherein the behavior of the experimental configurations is selected from a group consisting of thrust vectoring angle, thrust efficiency, and discharge coefficient.